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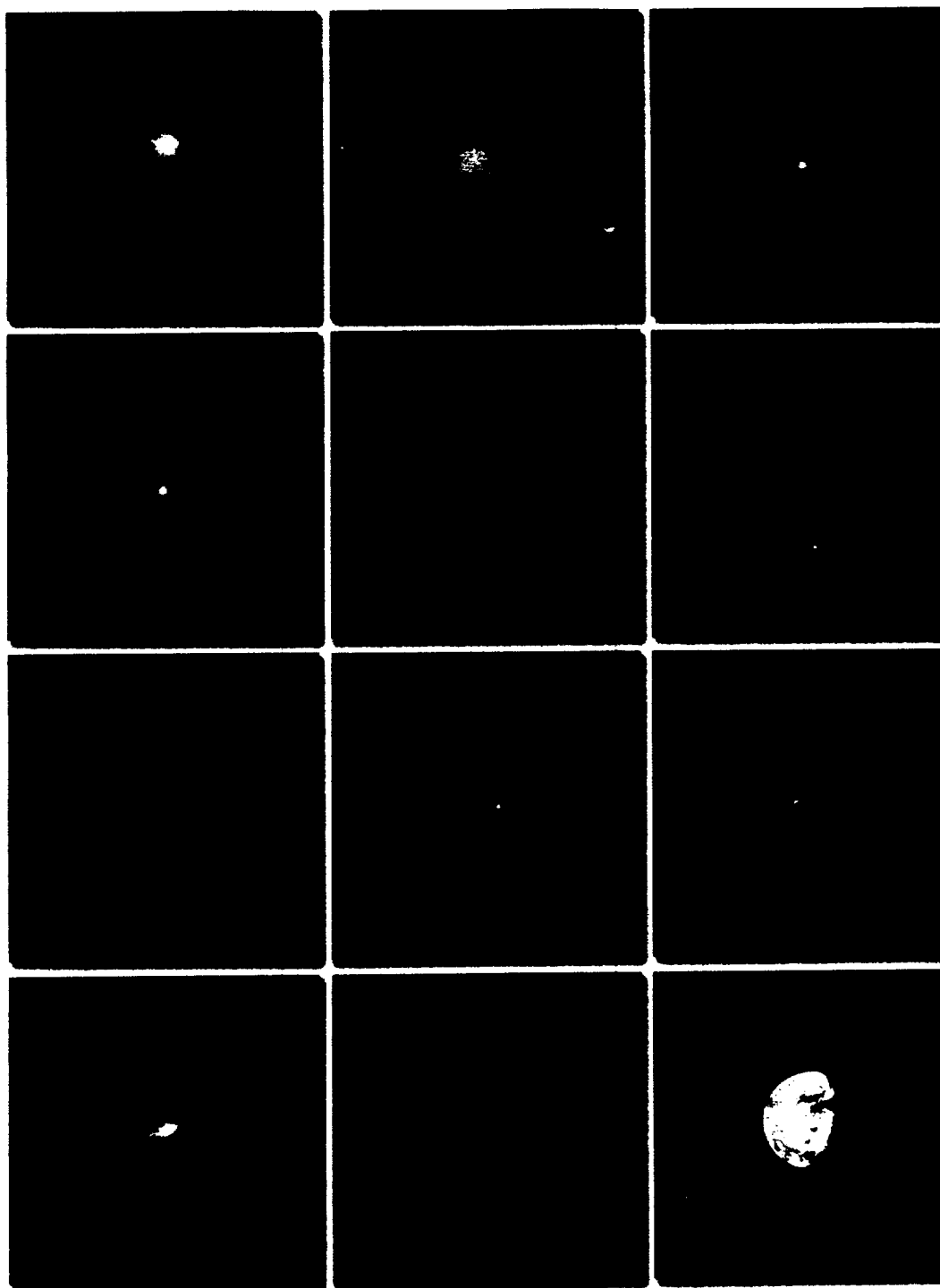
MULTI-YEAR NASA GRANT: NAG5-3762

ROBERT A. BROWN, PI

SPACE TELESCOPE SCIENCE INSTITUTE
3700 SAN MARTIN DRIVE
BALTIMORE, MD 21218

SPECIAL STUDIES IN SPACE EXPLORATION
Contributions of the Special Studies Office, Space Telescope Science Institute

Astronomy's Education Imperative
An Education Initiative in Astronomy
Imaging Other Planetary Systems from the Moon
Planetary Astronomy with a Large Space Telescope
A Call for an Education Initiative at NASA: Remembering the Road to Hagerstown
Progress in Extra-Solar Planet Detection
U.S. Presidents and Astronomical Discovery
Report of the HST Strategy Panel: A Strategy for Recovery
Space Optics for Studying Extra-Solar Planetary Systems
Solar System Exploration Division Strategic Plan
The National High School Debate on U.S. Space Exploration
A Planets Gallery for the National Air and Space Museum
An Exploration in Education
A Cassegrain Echelle Spectrograph
TOPS: Toward Other Planetary Systems
Terrestrial Impact Craters
Magellan at Venus
HST's Greatest Hits
The Future of Space Imaging
Endeavour Views the Earth
The World Factbook
Scientific Results from the GHRS
Images of Mars
Gems of Hubble 1.0
Magellan Highlights of Venus
The Impact Catastrophe that Ended the Mesozoic Era
Volcanic Features of Hawaii and Other Worlds
The Planetary System
Space Science for the 21st Century
The Electronic PictureBook and Astronomy's Education Initiative
Hubble Space Telescope Advanced Camera Conceptual Design
Gems of Hubble 2.0
Apollo 11 at Twenty-Five
Space Science Library of Electronic PictureBooks
Other Worlds from Earth
Windows on Orion
PlanetQuest
Comparing Earth and Its Planetary Neighbors
Gems of Hubble 3.0
The Red Planet: A Survey of Mars
Clementine Explores the Moon
Space Art by Kids
Cross-Platform Space Science Library of Electronic PictureBooks
HST & Beyond—Exploration and the Search for Origins: A Vision for
Ultraviolet-Optical-Infrared Space Astronomy
Education and Space
HST & Beyond Study
Endeavour Views the Earth (Cambridge University Press)
Gems of Hubble (Cambridge University Press)
Through the Eye of Hubble Screen Saver
ExInEd WWW Site
The Hubble Library of Electronic PictureBooks CD-ROM
CODEX Proposal
HST Commemorative Stamp Campaign
Origins Initiative Brochure
HST Second Decade Study
HST Second Decade WWW Site
CONTOUR WWW Site and support
AURA 40th Anniversary Postcards, Calendar, & Stickers



A sequence of twelve power-of-ten steps starting at Earth and arriving at an Earth-like planet around another star. An Electronic Picturebook — Other Worlds from Earth — is distributed free from our World Wide Web site, and on CD-ROM.

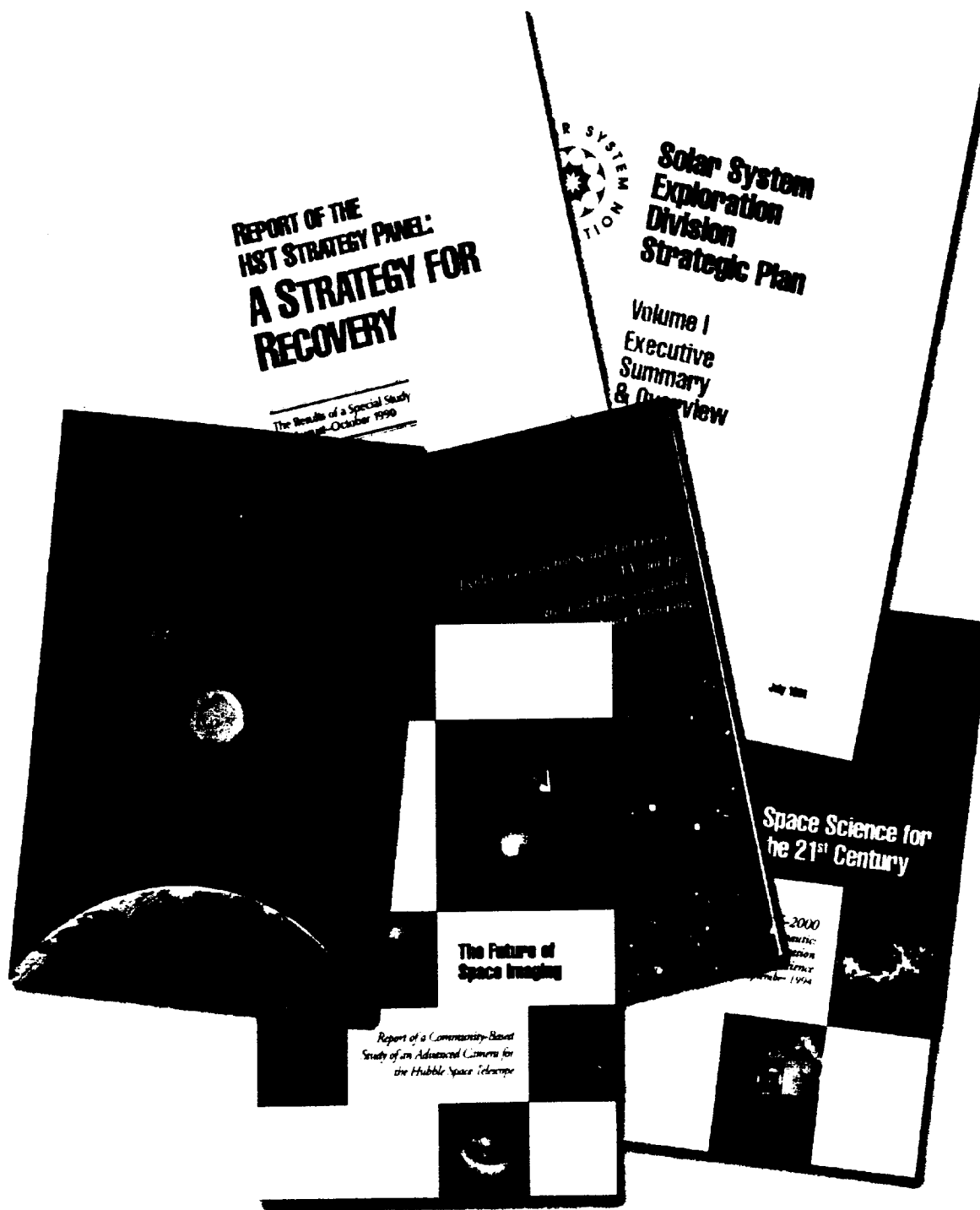
INTRODUCTION

Purpose

This is the final report of a program that examined the fundamentals of education associated with space activities, promoted educational policy development in appropriate forums, and developed pathfinder products and services to demonstrate the utility of advanced communication technologies for space-based education. Our focus was on space astrophysics and planetary exploration, with a special emphasis on the themes of the Origins Program, with which the Principal Investigator (PI) had been involved from the outset. *Teaching, Learning, and Planetary Exploration* was also the core funding of the Space Telescope Science Institute's (ST ScI) Special Studies Office (SSO), and as such had provided basic support for such important NASA studies as the fix for Hubble Space Telescope (HST) spherical aberration, scientific conception of the HST Advanced Camera, specification of the Next-Generation Space Telescope (NGST), and the strategic plan for the second decade of the HST science program.

Investment

This has been an 'education' program in the broadest sense. For the last eighteen years, Dr. Robert Brown, the PI, has played a central role in promoting strong education and outreach programs for NASA's space science. As NASA pre-launch Project Scientist for the HST in 1983-85, he advocated a program to define and assure HST's learning benefits to the nation. In 1989, he led a National Academy of Sciences study that produced the Bahcall Committee's "Education Initiative in Astronomy." In 1994, he authored the education policy for the planetary division's visionary *Solar System Exploration 1995-2000*. In multiple NASA advisory councils, working groups, and studies, Dr. Brown has consistently brought the education issue to bear on science planning. These efforts have been fruitful. Today, across the entire NASA program, the educational benefits of advanced space research and exploration are increasingly prized and pursued by scientists, managers, and space policy decision-makers.



Influential reports produced by the Special Studies Office with the infrastructure support of this grant.

To lend substance and innovation to our planning and policy activities, and with the encouragement of NASA, we have pursued a line of technology development for electronically-delivered educational products. In the process, we became a leader in the field of multimedia software for show-and-tell education based on space imagery, taking a lead in exploiting the Internet for the free delivery of such products.

Our infrastructure for authoring and publication—both print and electronic—became second to none in the space sciences. We have produced influential print reports, such as *A Strategy for Recovery* (1990), *Solar System Exploration Division Strategic Plan* (1991), *TOPS: Toward Other Planetary Systems* (1992), *The Future of Space Imaging* (1993), *Space Science for the 21st Century* (1994), *HST and Beyond* (1996), the prototype brochure for an interagency *Origins Initiative*, in 1997, and the report of the HST Second Decade Committee. We have also developed a major World Wide Web (WWW) presence to take advantage of the Internet for space science education and outreach, including maintaining the home pages for such activities as *Exploration in Education* (ExInEd), the Hubble stamp initiative, and Comet Nucleus Tour (CONTOUR) mission. Assets provided by this grant have made possible the PI's prose and graphical contributions to the education and outreach efforts of the Space Interferometry Mission (SIM) and the Terrestrial Planet Finder (TPF), on which Science Working Groups Dr. Brown was a member.

Past NASA investment in our skills, experience, and communication infrastructure continues to serve NASA, the public, and the space science community.



The 16 currently offered titles of our innovative, cross-platform EPBs.

Approach

Our approach consisted of thoughtful reflection and bold action. The thoughtfulness pertains to the wide variety of ways in which space activities impinge beneficially on the learning mind. The direct results of space are in the area of science and engineering, but the indirect effects are broad and numerous: the explorations are cultural expressions, philosophical propositions, as well as unparalleled opportunities for individual creativity to meld with the well-managed efforts of hundreds of people to achieve grand success. Recognizing the space science's potential to engage, inspire, and improve the lives of ordinary citizens informed our efforts and advocacy on behalf of the NASA program as a whole.

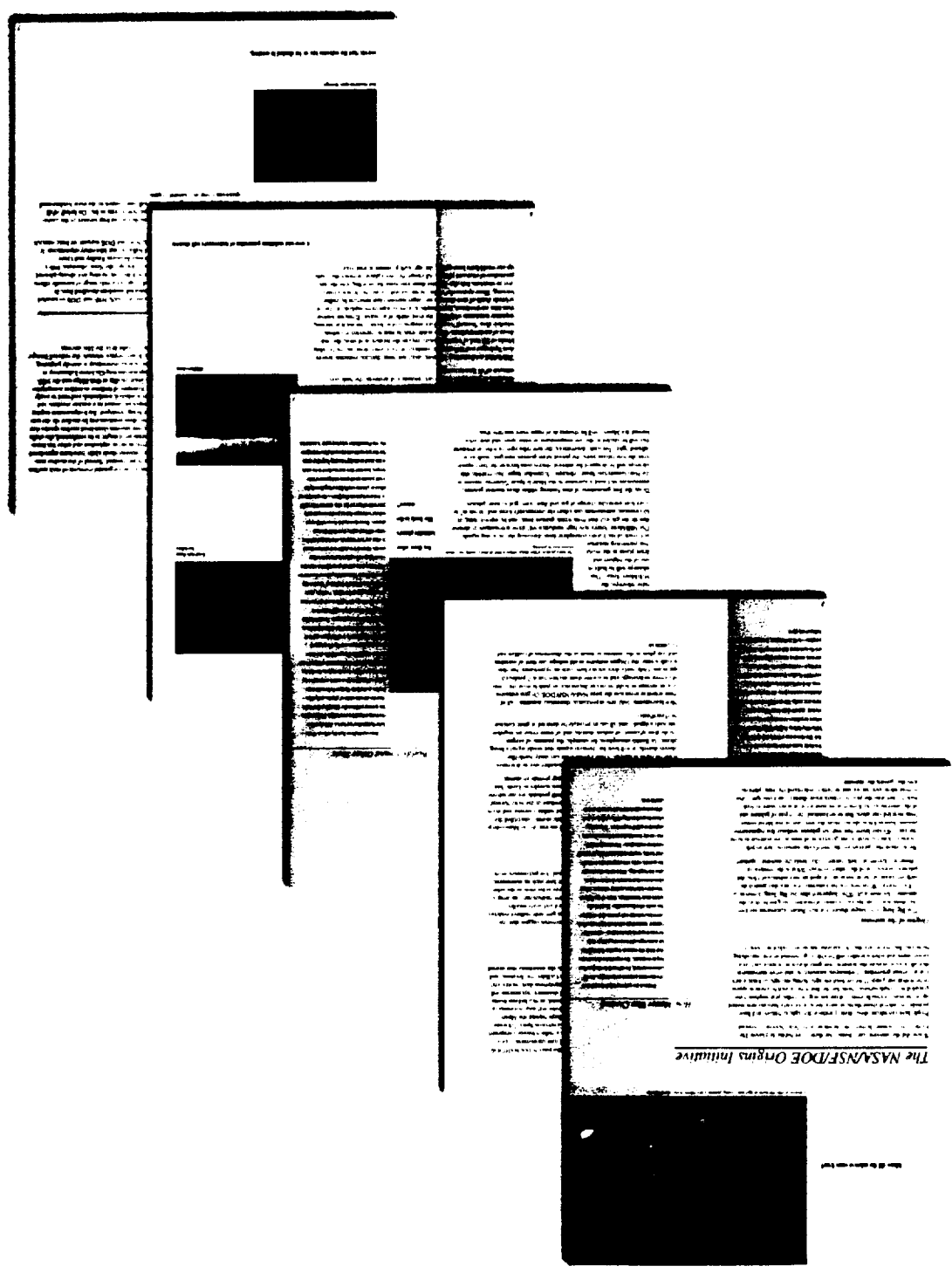
We took bold action in developing a new technology for delivery of space science results to homes and schools via computer communications networks.

We invented the Electronic PictureBook (EPB), which is a modular, rapid-development, show-and-tell technology. We produced 16 titles and developed a strong presence on the Internet. Many thousands of these products have been distributed at no cost to the user through our WWW site, ftp site, and via email.

Funding

The funding of this proposal primarily supported the technology-development facet of our program, which was the keystone of the entire SSO effort. It enabled crucial experimentation with electronic methodologies, lent credibility to what would otherwise be unexamined theories about the nexus between education and space, achieved real educational benefits in the process of demonstration, and maintained the SSO infrastructure for support of the HST, CONTOUR, and SIM missions.

A sampling of pages from the prototype brochure
for an inter-agency Origins Initiative.



ACCOMPLISHMENTS

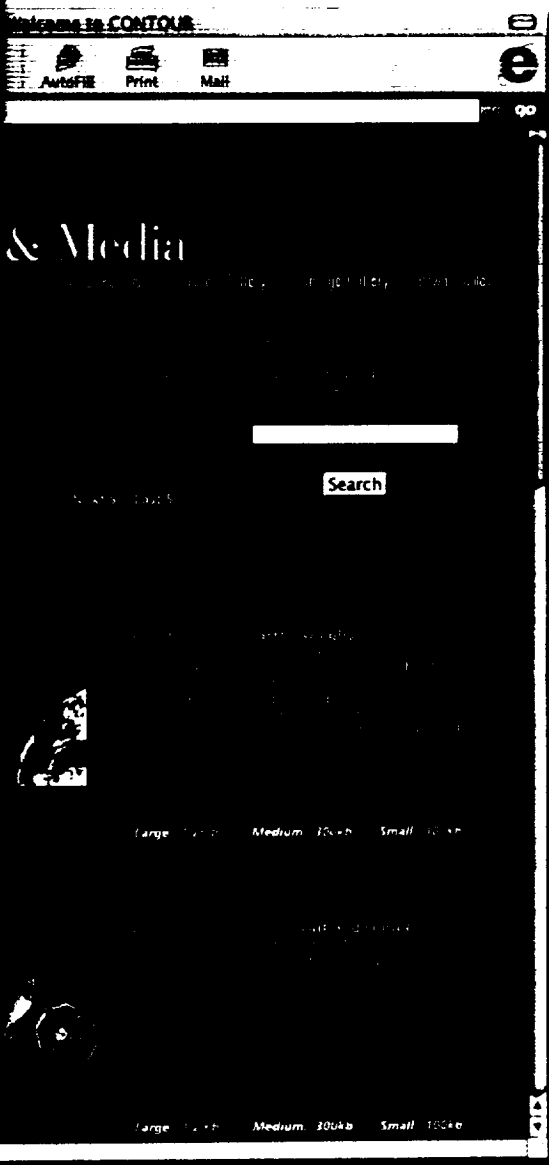
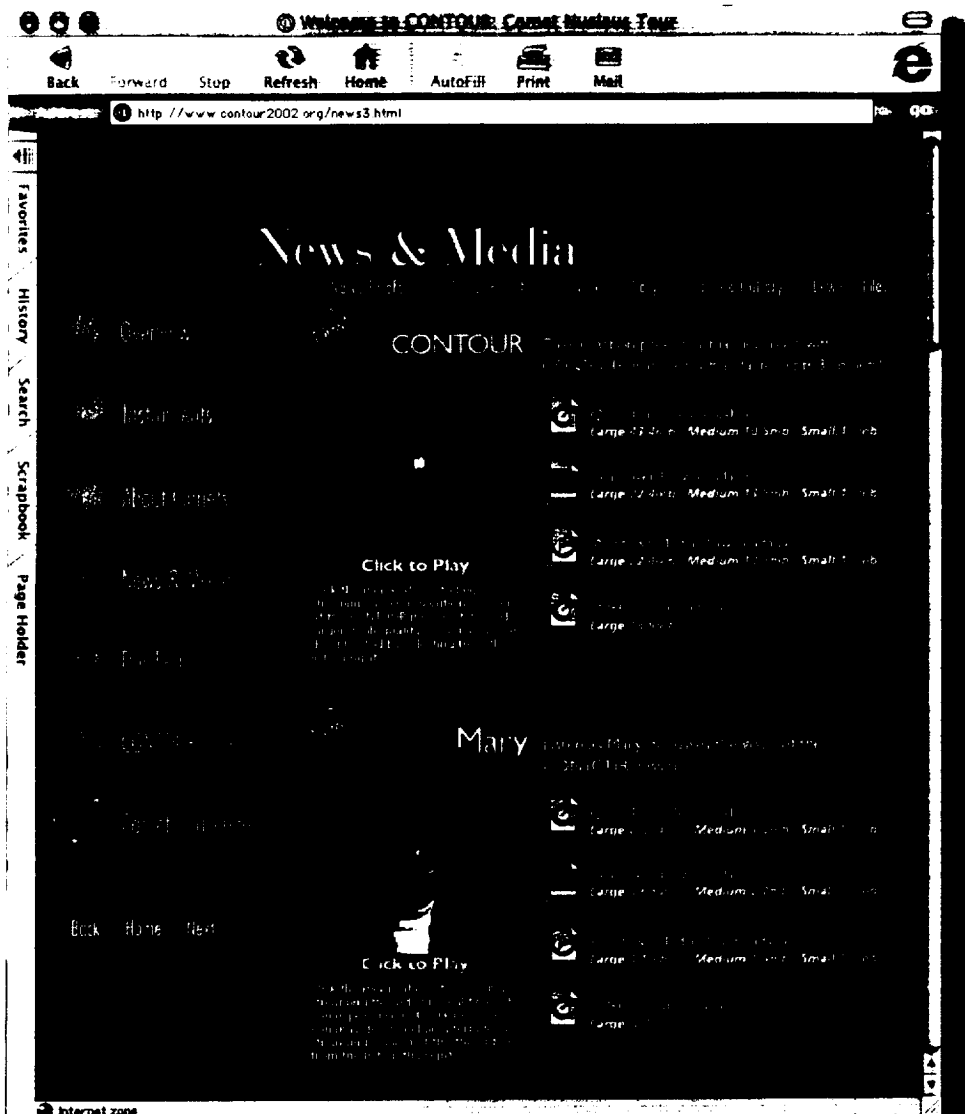
This grant, *Teaching, Learning, and Planetary Exploration*, was the core funding of the SSO at ST ScI, which served the entire astronomical community with strategic studies related to NASA's Origins Program in general and HST in particular. Our program was to explore, discover, and develop new ways of relating space science activities to basic teaching and learning.

In the last few years of this grant, we devoted almost all of our research and development efforts to WWW based projects. In the initial years of our funding, when the WWW was just beginning to emerge as a viable education tool, we guided our research toward an infrastructure that would allow us to grow with the web.

We have the HST Second Decade Study, a community-based effort to produce a strategic plan for optimizing the science return from HST in the second half of its mission. Over the past ten years and continuing into the new millennium, such studies and their print and electronic products proved more effective and efficient because of the infrastructure created and maintained by this grant.

WWW-BASED ACTIVITIES

With a focus on increasing the size of our audience and the amount of educational information disseminated, we succeeded in designing, developing, and hosting two new educational WWW sites, in addition to our primary ExInEd WWW site (<http://www.stsci.edu/exined/>). These recent site developments were technically significant because they include physical hosting, and not simply design and creation. The new technical skills required to achieve this expanded capability was important for our Internet presence. Locating, maintaining, and administering the two new WWW servers on-site, greatly enhanced our autonomy, and, therefore, the ability to react quickly to emerging situations and provide the best service to our audience.



CONTOUR Education and Public Outreach Website

The PI is a scientific co-investigator on CONTOUR—a Discovery Program mission. Due primarily to research into web-based information dissemination afforded by this grant, the CONTOUR website (<http://www.contour2002.org>) has become the hub for the project's ambitious public outreach plan. (Only CONTOUR funding was used for the CONTOUR website development.)

Our early exploration of online, rich-media content delivery developed into a fully deployed streaming audio and video platform for the CONTOUR mission. Over 20 gigabytes of online video streams from the server each month. Furthermore our research into delivering our Electronic PictureBooks for multiple computing platforms informed our design of the streaming video infrastructure. All our video content is available in formats optimized for individual computing platforms—Macintosh, Windows, and UNIX as well as varying levels of internet connectivity—from low bandwidth modems to high-bandwidth intranets.

Our research with image/data archive systems helped with CONTOUR and other projects. In the CONTOUR website, we incorporated an online image archive that is driven by database. Each image is tagged with 'metadata' providing keyword information about the image. This information along with other relevant items—like posting date, image title, and description—are stored alongside the image within each record of the database. This allows the user to query the archive to retrieve only the images he or she desires. Images are stored in multiple formats to suit each user's various needs and capabilities.

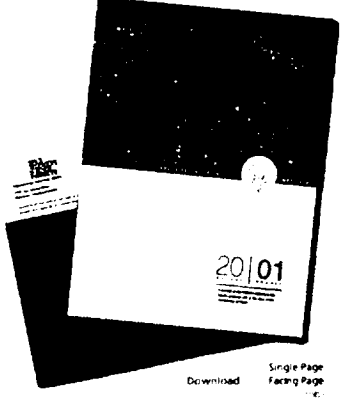
Infrastructure development from previous projects for the online collection of user feedback and requests—the solicitation of opinions for our Hubble Postage Stamp series, the online scientific forums of the Hubble Second Decade website, and the submission of specific online form data from our HubbleArchive research—were used for the national CONTOUR Comet Challenge—a nationwide 'call for proposals' to K-12 students and their teachers to develop a comprehensive outreach plan incorporating CONTOUR comet research into the classroom.

Address: http://sci.stsci.edu/annualreports/

SPACE TELESCOPE SCIENCE INSTITUTE

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STScI Annual Reports



Download Single Page Facing Page

The 2001 Space Telescope Science Institute annual report has arrived. With a new, goals and achievements-oriented structure, more new manager profiles and science essays, and new self-improvement and strategic plan sections, this report is our most comprehensive to date.

2001
Single Page Facing Page

1999
Single Page Facing Page

1998
Single Page Facing Page

Science Initiatives

- HDF
- HDF South
- Starburst Galaxies
- GOODS

Catalogs & Surveys

- Guide Star Catalog
- Digitalized Sky Surveys
- Guide Star Photometric Catalog
- Catalogs of Variables
- Spectra of Nearby Galaxies

Meetings

- Colloquia
- Popular Talks
- May Symposium

Publications

- Press Releases
- STScI Library
- Annual Report
- STScI Newsletter
- HST Administrator
- Conference Proceedings

Software

- Pipeline Processing
- Planning & Scheduling
- StarView
- Data Analysis
- Data Compression
- PDF Modeling

Hardware

- Detector Testing

Picture Gallery

- Hubble Images
- Hubble Heritage

Educational Activities


Internet.com

Address: http://sci.stsci.edu/annualreports/

SPACE TELESCOPE SCIENCE INSTITUTE

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Institute Newsletter



Download the Spring 2002 Issue PDF 1.1 MB

Current Issue Highlights: Spring 2002

- Hubble Treasury Program
- Hubble Calibration Workshop
- Web Tools: APT & SpecView
- HST Transitions to a New Phase
- Hubble History: The HST Story
- Interview with Megan Donahue

2001

- 1999
- 1998
- 1997
- 1996
- 1995
- 1994

Winter 2002

PDF 1.0 MB

Fall 2001

PDF 2.3 MB

Summer 2001

PDF 2.3 MB

Enter keywords: Go

The web page is the best of the Newsletter PDFs ready. The web page will update the content of the PDFs that contain the specific search results.

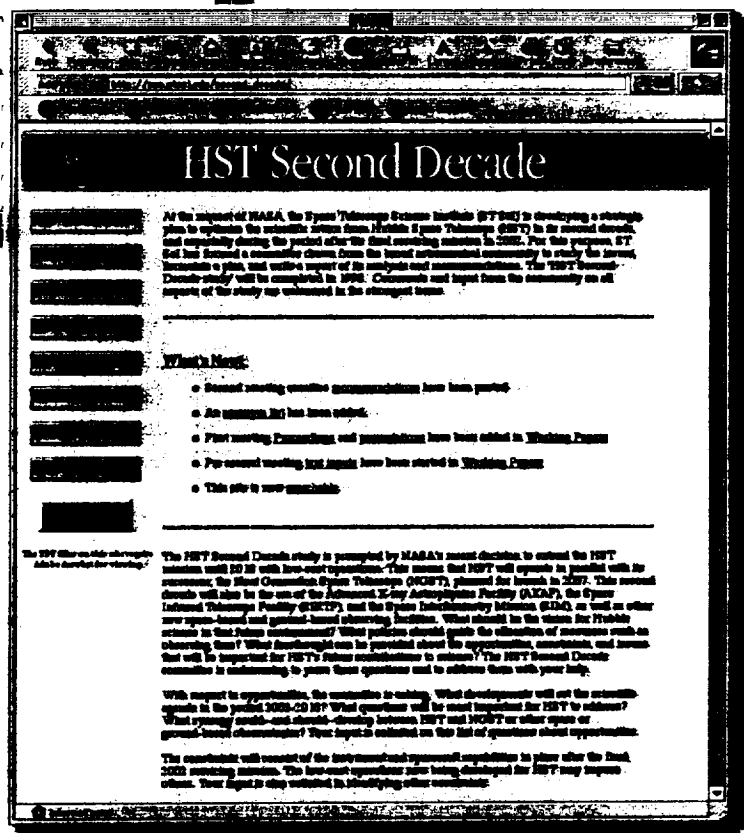
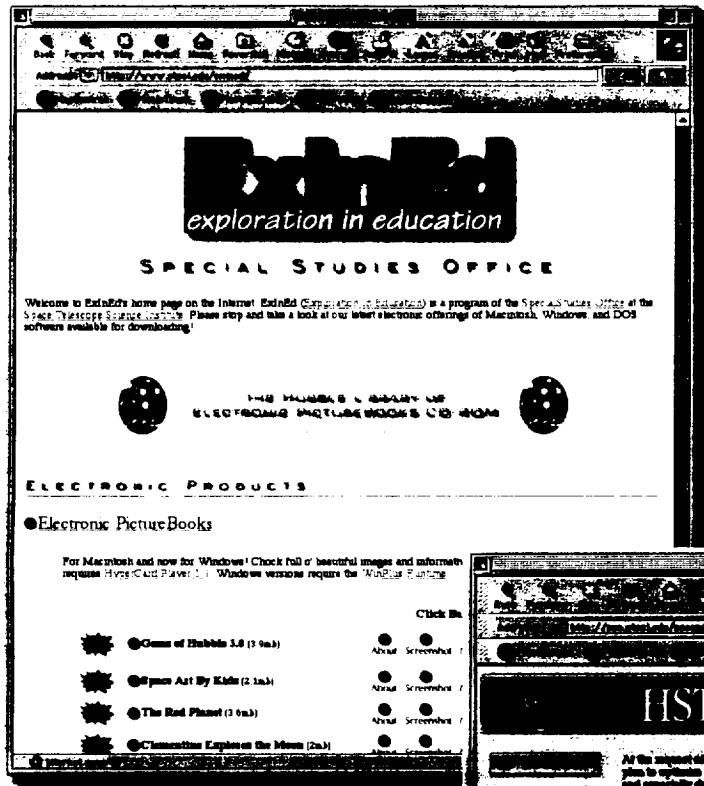
Internet.com

Under this grant, our overall electronic communications infrastructure consisted of on-site, dedicated WWW, File Transfer Protocol (FTP), Secure Sockets Layer (SSL), Local Area Network (LAN) file, print, and email servers. Our Internet-based servers became capable of handling all state-of-the-industry protocols including advanced, real-time, media-streaming protocols, online document publication protocols, and industry standard security and encryption protocols.

Further, our infrastructure was optimized for rapid, online, content conversion from traditional media and offline sources. We could acquire data from almost any source—analog or digital, local or remote—with numerous analog-media content acquisition devices such as film, flatbed, and 3D scanners, as well as software for character and pattern recognition, and HTML conversion and authoring. The interconnection of these assets on our robust networking infrastructure ensured minimal development time and rapid publishing of information on the Internet.

ExInEd WWW Site

At the ExInEd WWW site, users can download at no cost all of ExInEd's popular EPBs, the multimedia Electronic Tutorial *Cepheids in M100*, and a selection of Electronic Reports. Summary information about each of the items, including screen shots of selected pages, is also available on the WWW page. We have continued to provide technical support for all EPBs to teachers, students, and other online users.



WWW-based EPBs

We expanded ExInEd's strong WWW presence by incorporating new Internet-based technologies to deliver digital content in "real time." Using our new, dedicated, on-site WWW Server, ExInEd successfully developed the first prototype of a future series of EPBs delivered and displayed in a window within the user's WWW browser. This "streaming" technology downloads and displays only those parts of an EPB currently being used, thus eliminating the lengthier and more involved download, extraction, and installation procedure normally required to use an EPB. Because these real-time, streaming EPBs are WWW-based, they run on multiple platforms, including Macintosh and Windows. The streaming EPB can be viewed at <http://exined.stsci.edu/shocked/>.

HST Second Decade WWW Site

This site was the storefront for the HST Second Decade Committee, which NASA formed to determine the focus and strategies of HST activities during the telescope's second ten years of operation. The site was technically advanced, using database-driven content delivery, real-time data querying, and streaming online-document delivery. The site was open to the community and provides a mechanism for feedback that has significantly informed the study's progress.

THE WHITE HOUSE
WASHINGTON

February 28, 1997

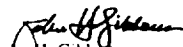
Mr. Terry McCaffery
Citizen's Stamp Advisory Committee
Room 4474E
U.S. Postal Service
475 L'Enfant Plaza S.W.
Washington, DC 20260

Dear Mr. McCaffery:

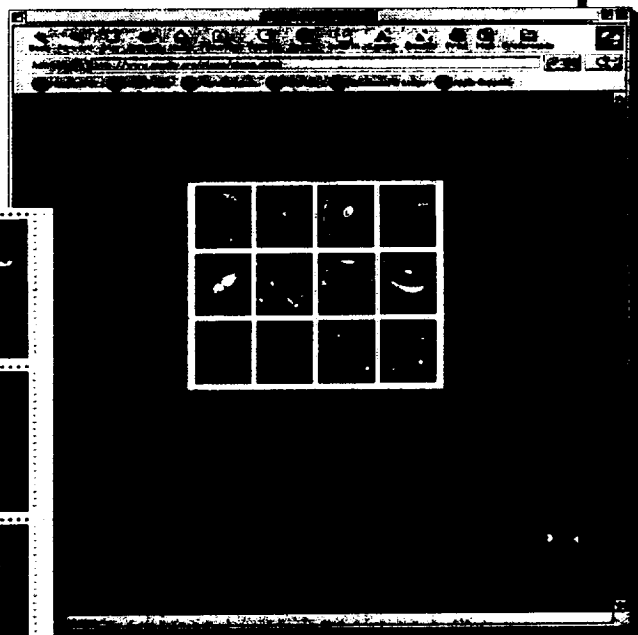
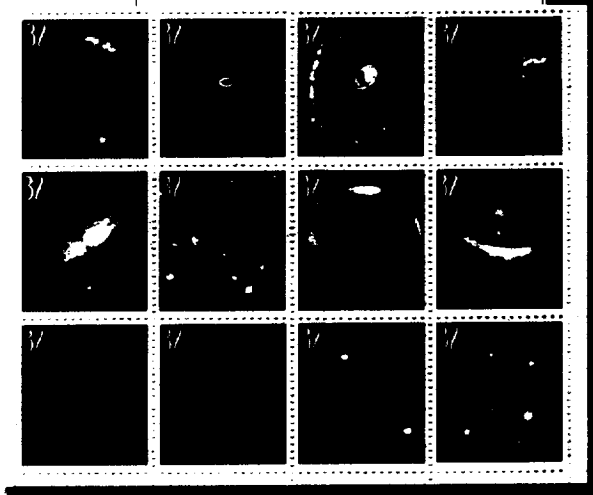
I have been privileged to see a sample sheet of possible postage stamps based on Hubble Space Telescope images. They are striking in appearance and rich in scientific content and educational value. What better way to share these new discoveries about our solar system and universe with every man, woman, and child across America, than through postage stamps?

Placing these images on stamps would make a powerful statement about the frontiers of knowledge and about the impressive technological capabilities of the United States to explore the universe for the benefit of humanity. I hope the Citizen's Stamp Advisory Committee shares these views, and will act favorably on the proposal submitted last month by Robert A. Brown of the Space Telescope Science Institute.

Sincerely,


John H. Gibbons
Assistant to the President
for
Science and Technology

cc: R. DalBello, OSTP
J. Hofgard, OSTP
D. Goldin, NASA
P. Brown, ST ScI
F. Williams, ST ScI



The HST Stamp proposal endorsement by John Gibbons, former presidential science advisor, ASP-hosted WWW site, and the printed example illustrating the idea.

EDUCATIONAL ACTIVITIES USING PRINT MEDIA

ExInEd expanded its presence in the non-electronic, traditional media arena with a U.S. stamp proposal, several printed products, and support for an exhibit of Hubble images at the NAS in April 1999.

U.S. Postage Stamp Proposal and Printed Example

We initiated a recommendation to the U.S. Postal Service calling for a stamp set to commemorate the achievements of the Hubble Space Telescope. Hubble images continue to enhance public awareness of the beauty of the cosmos and the value of scientific space exploration, and it is our belief that a Hubble stamp set would bring these benefits to an even broader audience.

To aid in this campaign, we created a highly-realistic printed example of a possible Hubble image stamp sheet. This example has been widely admired generating numerous written endorsements from both within and outside the astronomical community, including a strong endorsement from the science advisor to the President of the United States.

The Hubble stamps were issued in 1999, following our original design quite closely.

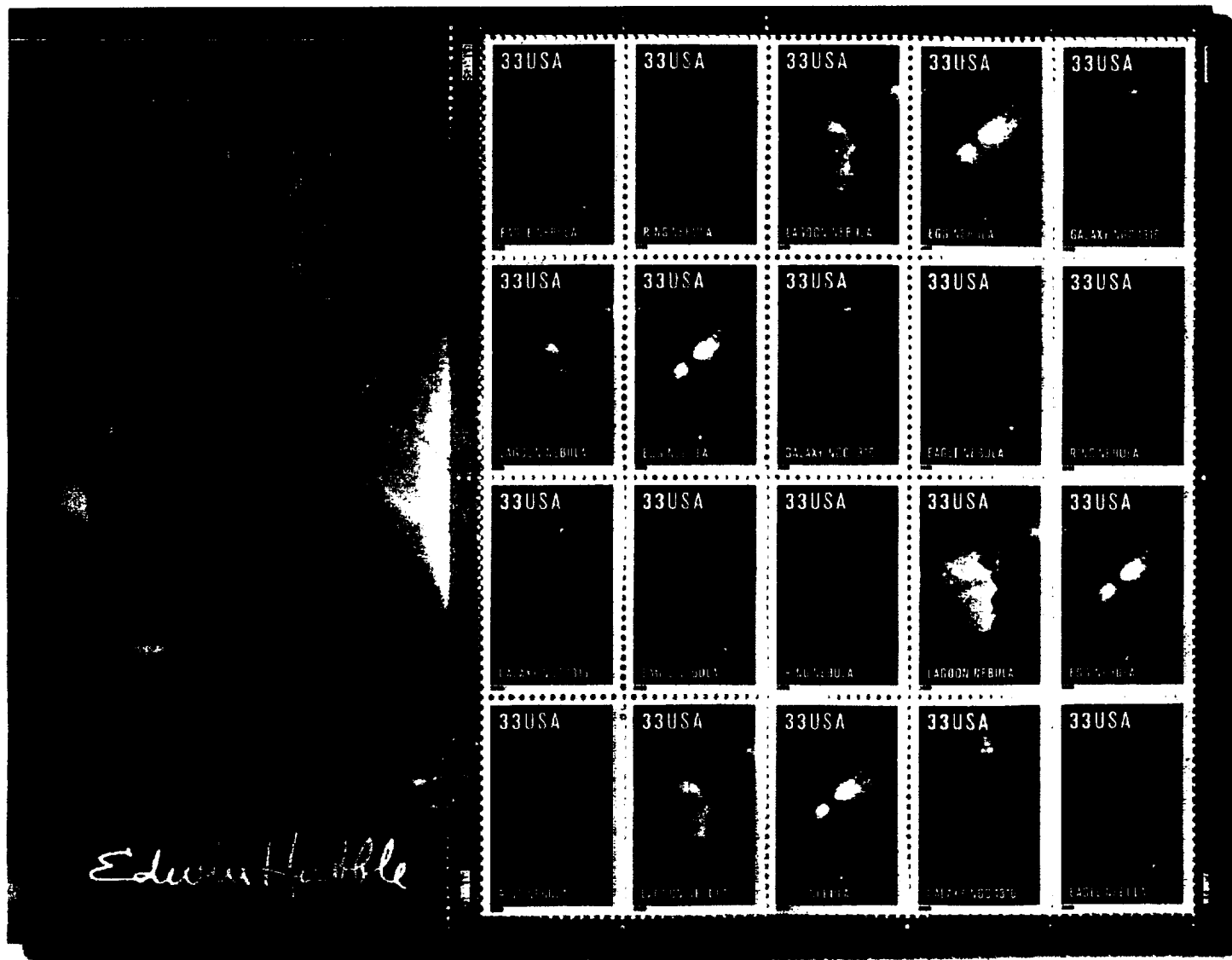
U.S. Postage Stamp Proposal Web Site.

To help educate the public about the proposal for a Hubble commemorative stamp set, we created a WWW page later hosted by The Astronomical Society of the Pacific at <http://www.aspsky.org/stamp/stamp.shtml>. The page averaged 15 visitors per day and generated hundreds of letters of support from the public. The following are a sampling of the public's overwhelmingly positive comments:

The Hubble Space Telescope has not only shown beautiful images of space, but it has allowed people to become educated at the same time. I believe that there should be a stamp to recognize the beauty and education that the telescope offers.

—Suzanne Schapira

I would love to see Hubble images on U.S. stamps. The images are so beautiful. I also think



it is important to stir interest in Astronomy. Our universe is so awesome. We become more aware of ourselves the more we are aware of the creation around us.

—Estelle Rapp

My eight grandchildren range in age from four to fifteen years. They have seen some of the images that have been sent back to earth by this amazing technology. They have many questions about what they have seen. Who knows? Maybe one or more of them will help provide the answers.

—Anonymous

My dad, Fred Reschke, worked on HST for many years (LMSC, Sunnyvale, CA, and GSFC, Greenbelt, MD). Unfortunately, he has passed away. These stamps are a tribute to everyone who has worked hard over the years to make the HST dream come true. They also let the world explore space as never before. I support the cause to help make these stamps a reality.

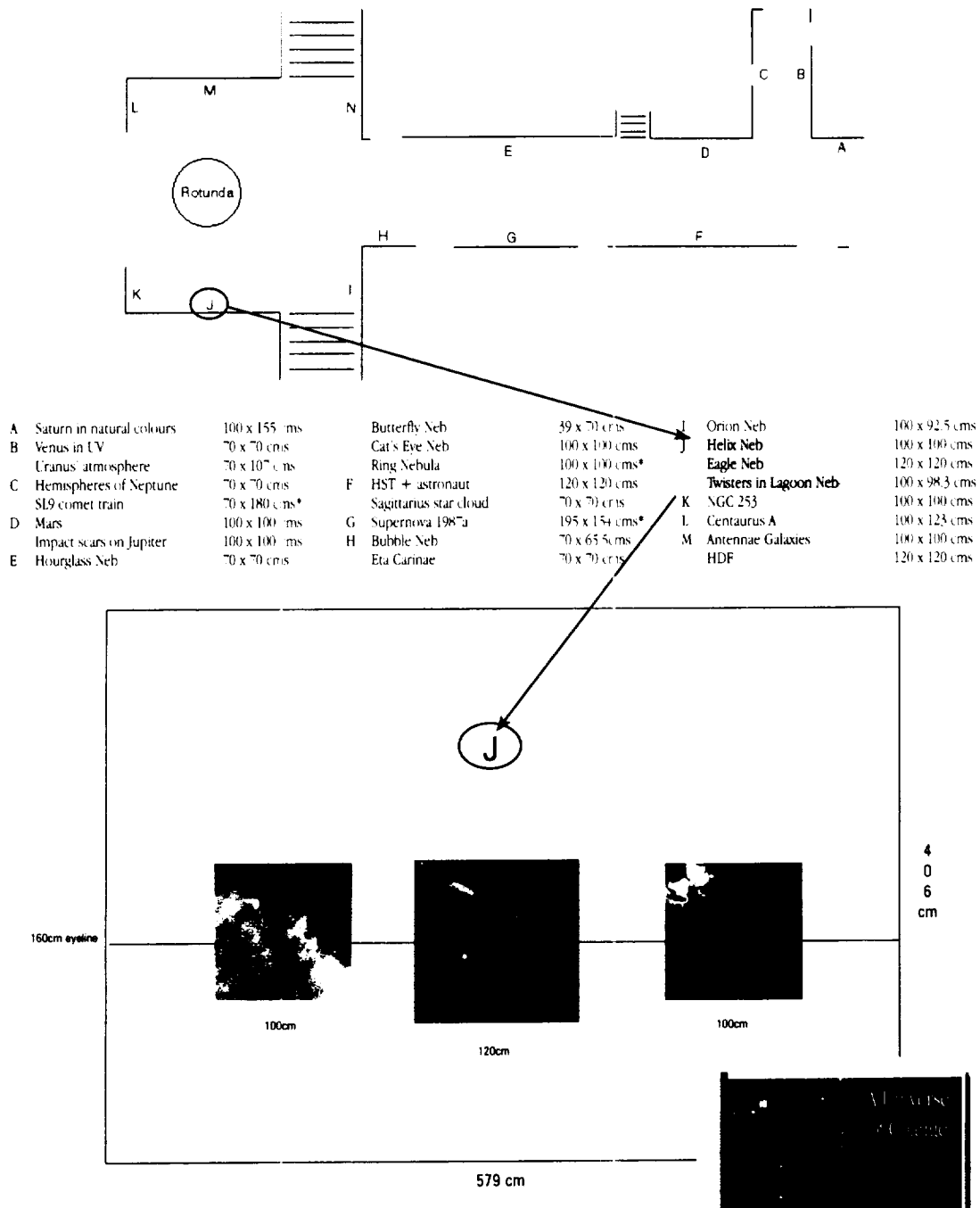
—Melinda Reschke

HST Postcards, Calendars, and Stickers

We leveraged our expertise and technical resources in print media to create three, high-quality, unique, printed pieces to commemorate the 40th anniversary of the founding of the Association of Universities for Research in Astronomy, Inc. (AURA). Following a request from AURA to “help us celebrate this event,” these technically sophisticated products were a set of 13 full-color, glossy postcards, a full-color, tri-fold wall calendar, and a set of twelve full color, self adhesive stickers. Due to our careful research, planning, and preparation, the jobs were produced on-time and on-budget with no technical mistakes or compromises in quality. (This effort was paid for entirely with AURA funds.)

NAS Gallery Exhibit

We wrote a proposal for an exhibit of HST images entitled “A Universe of Change,” which has been approved by the NAS for display starting in April 1999. This exhibit will include twenty-six mostly new images tied together by the theme of dynamical change observed by Hubble in a variety of astrophysical phenomena, from weather on planets to star formation to stellar death to the expansion of the Universe. (The production of this exhibit is entirely funded by non-grant sources.)



The proposed National Academy of Science gallery exhibit has been reviewed by artists, educators, and gallery curators for both educational and aesthetic value.

SOFTWARE DEVELOPMENT ACTIVITIES

HubbleAccess Software

We developed the concept for *HubbleAccess*, a software product designed to simplify the user interface with the Hubble Data Archive (HDA). Obtaining the desired data from the current HDA is a complex and confusing process for the less technically-trained public. *HubbleAccess* was to be a turnkey solution to remedy the problem and achieve broad, hands-on access to Hubble data. It would have provided, in one package, all of the tools and procedures necessary for non-scientific users to successfully retrieve, view, and modify any public image or dataset found within the HDA.

The *HubbleAccess* basic product description:

Overall Goal: Provide access to the Hubble Data Archive via an easy-to-use interface designed for the amateur astronomer and professional educator, and provide tools to make Hubble data files usable and understandable for the same audience.

Initial Target Audience: Amateur astronomers, professional science educators, students (high school and higher).

Packaging: Data access and data manipulation tools on CD or DVD. Data sampler on same medium, with additional data volumes available (e.g., grouped by subject or phenomena, such as Galaxies, Planets & Asteroids, Star Clusters, Planetary Nebulae). Network access to full Hubble archive for users who wish to go beyond CD/DVD contents.

User Interface: Data catalog browsing and searching requiring minimum of astronomical expertise (e.g., familiarity with basic astronomical object and phenomena assumed, but not with subtleties of expressing coordinate systems, time systems, object naming conventions, etc.) and no particular knowledge of HST instruments. Access to thumbnail or preview images.

Platforms: W95/98/NT, Mac, possibly Linux.

Performance: Immediate/real-time access to catalog, preview images, and significant sample of real HST data. Basic package should not require direct network access to ST ScI/Hubble Data Archive, but such connections would be available to the user.

Data update subscriptions: Given the rate of new science being done with HST, HubbleAccess CD/DVD data volumes will need to be periodically updated. Subscription holders would receive these updates automatically.

We were pursuing a partnership to develop *Hubble Access* with other than grant funds. This effort did not succeed.



The Hubble Library of Electronic PictureBooks and Through the Eye of Hubble are distributed commercially using entirely non-government funds.

TECHNOLOGY TRANSFER ACTIVITIES

Using non-government funds we successfully pursued the amplification factor of commercial distribution to obtain wider dissemination of our show-and-tell education products.

CD-ROM: The Hubble Library of Electronic PictureBooks

The ExInEd-produced CD-ROM, The Hubble Library of Electronic PictureBooks, was sold steadily through various distributors, including the Astronomical Society of the Pacific, NASA CORE, and several museum stores.

Screen-saver: Through the Eye of Hubble

Sales for Second Nature Software's screen-saver Through the Eye of Hubble, which was produced with the technical and creative support of the ExInEd program, exceeded 50,000 copies. No government funds were used to prepare commercial products for sale.

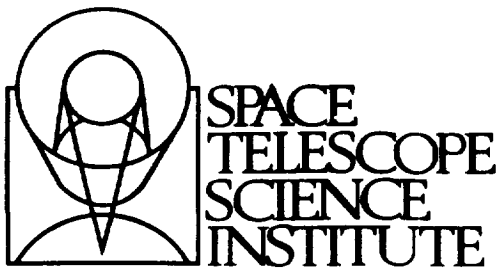
OTHER ACTIVITIES

NASA Teacher Resource Center Support

ExInEd's Electronic PictureBooks continue to be available for free copying by teachers at NASA Teacher Resource Centers. Technical support is also provided for these users of ExInEd materials.

ExInEd Archives

ExInEd continues to maintain an electronic database and hard copy archive of Hubble materials as they are released. Other ExInEd materials, including its vast library of Electronic PictureBook images and text, have been archived to CD-ROM and are searchable via an electronic database.



3700 San Martin Drive
Baltimore, MD 21218
(410) 338-4586
FAX (410) 338-4525

September 13, 2002

Harold D. Coleman
Grants Officer, Code 210G
NASA / Goddard Space Flight Center
Greenbelt Road
Greenbelt, MD 20771

Ref: Closeout Documentation for NAG5-3762
STScI Project Number: J0511

Dear Mr. Coleman:

Enclosed please find the following closeout documentation for the above referenced grant, *Teaching, Learning, and Planetary Exploration*, under the direction of Dr. Robert Brown.

Final Performance Report
Final Financial Report
Final Property/Inventory Report
Final Patent/Invention Report

Should you have any questions or require additional information, please do not hesitate to contact me at (410) 338-4586 or mcquay@stsci.edu.

Sincerely,

A handwritten signature in cursive script that reads "Joy Hayes McQuay".

Joy Hayes McQuay
Sponsored Programs Administrator I
Contracts and Sponsored Programs

Enclosures

cc: PI
Technical Officer
CASI, Acquisitions Department ✓
ONR, Closeout Team